

UDK 004.891.2

Virtual laboratory of physical research of materials

Bondarenko M., Bondarenko Yu.

Cherkassy State Technological University, Cherkasy, Ukraine

***Annotation:** Possibility of creation of on principle new variety of virtual laboratory of physical research of materials is considered in the article. On an example created in International educational and scientific Center «Micro- and nanotechnologies and equipment» at the department of physics of the Cherkassy State Technological University of laboratory of physical research of materials its functional possibilities, connection with other laboratories and perspective of development, are proven. The feasibility of the implementation of such a virtual laboratory, both in the educational process and in industry, as well as for research works has been proved. The main advantages of the virtual laboratory were identified, namely: functionality, speed of research, maximum elimination of external destabilizing factors, such as: climatic influences, human impact, subjective measurement errors, etc.*

***Keywords:** virtual laboratory; physical material science; Technological University; nanometric research; atomic force microscopy*

In spite of the fact that no momentous openings almost were done in the last decade, development of such sectors of scitech, as engineering, micro- and nanoelectronics, computer and informative technologies, medicine, research of materials developed considerably. So, on information of UNESCO, more than forty thousand firms and organizations appeared in the world from 2000 to 2015. Activity them related to development and introduction of modern high-tech, including nanotechnologies. It on 30% more than in the last decade of past century. A study and use of such technologies requires greater qualification, intellect and mobility of modern engineer-technologist. It must be mortgaged in basis of the program of teaching of future specialist from an university bench.

However, in spite of high qualification of the professorial and teaching staff and high theoretical level of teaching of disciplines in a modern technological university, and also providing of educational process the newest computer and informative and of communication technologies is observed substantial lag of laboratory-practical base of university from the modern material and technical base of scientific and production complexes and research laboratories in which coming to work future specialists.

An exit from this situation is seen in creation of virtual scientific educational and research laboratories which are oriented to taking away of problem of logistical support of educational process.

We will consider the prospect of creation of its laboratories in a modern technological university on the example of work of virtual laboratory of physical research of materials, which was created on the base of International educational and scientific Center «Micro- and nanotechnologies and equipment» (IESC MNTE), organized at the department of physics of the Cherkassy State Technological University (Ukraine) [1].

Existing today not numerous virtual laboratories are limited in the functions and anymore present virtual laboratory works, demonstration materials or virtual devices (for example, virtual electro- and radio measuring equipment of firm «AKTAKOM»).

However, to our opinion a modern virtual laboratory which must take a place in a technological university must present the complex of the real devices and methods for providing of valuable research within the framework of the put tasks.

Developed in Cherkassy State Technological University the virtual laboratory (VL) of physical research of materials behaves [2] to the new generation of the hybrid systems of accumulation, analysis and representation of knowledge's, uniting in itself the procedural and declarative models of the intelligence systems.

Aims of developed of virtual laboratory: 1) to provide interactive communication between an existent scientific equipment, which is possessed by IESC MNTE and users, remotely remote from an equipment; 2) to carry out integration with the virtual laboratories of direction of research of materials for creation of general base of the accumulated knowledge's and association (at virtual level) of equipment which does not possess separately taken VL.

Basic tasks which decide scopes of virtual laboratory:

- increase of activity of students in the process of their educational and research activity;
- improvement of perception of working material, his adaptation to the educational process, and also facilitation due to his multimedia process of mastering of material during independent work of students;
- maximal unloading of the real educational-research laboratories from the lessons of students;
- acceleration of process of preparation and writing of qualifying and research works due to the economy of preparation time and leadthrough of experiments;
- an accumulation of the purchased knowledge's is in the public base of data, which easily adapts oneself under different databases and CAM-systems.

In addition, easily to unite a virtually existent laboratory with other, by similar laboratories.

Structure created in IESC MNTE presented a virtual laboratory on fig.1.

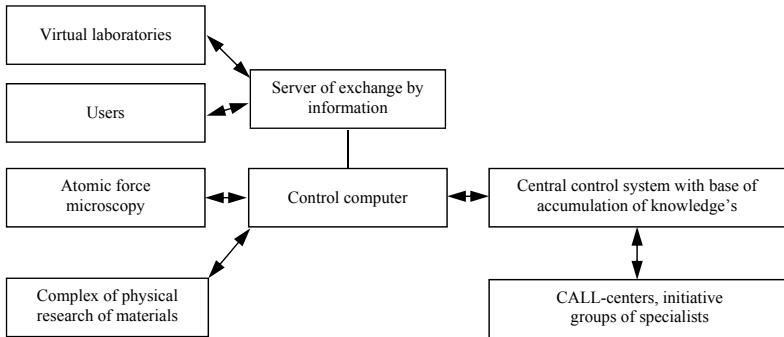


Fig. 1. Structure of virtual laboratory of physical research of materials

We will consider destiny of separate blocks of this laboratory. A control computer is carried out by connection between an existent equipment: by the atomic-power microscope of NT-206, measuring complex and control the system this equipment. On this stage a highly skilled operator makes necessary manipulations for the receipt of primary information about the probed object.

The information got directly on devices about the probed object enters the central sensor-based system, the basic setting of which is treatment of the got information, its maintenance in the base of these accumulated knowledge's. In the complement of database developed VL enter structural description of descriptions of the examined materials, illustration materials (pictures, video, animation etc.), and also information which already passed treatment and/or were modeled in the specially developed mathematical packages. An exchange and processing of data, and also selection of general descriptions and functions of findings, is carried out by external CALL-centers and initiative groups of specialists in the certain questions of physical research of materials.

Treated thus information through the server of exchange of information can be accessible for other VL (as working material during the leadthrough of complex researches) or for separate

users: youths of scientists, master's degrees or graduate students (as results of experiment of scientific researches) or students (as educational material).

Another perspective direction, realized by developed VL, is a leadthrough of interactive lessons and consultations with bringing in of specialist of physical research of materials in the process of creation and organization of such employments.

We will consider how the virtual laboratory of physical research of materials will be realized in IESC MNTE [3].

To organization of VL complex approach was used in IESC MNTE, when acquisition, teaching and accumulation of knowledge's, was provided on all of the stages of research process (fig.2).

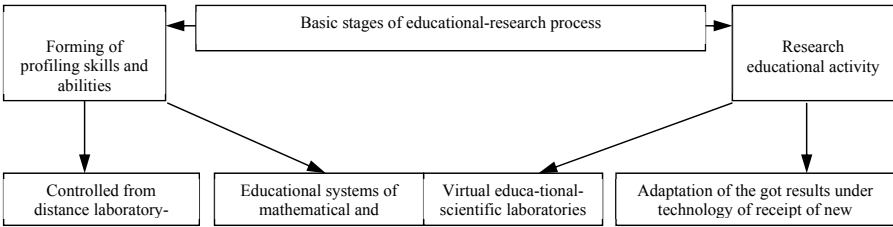


Fig. 2. A virtual laboratory of physical research of materials is in a modern technological university

On the initial stage of creation of base of these accumulated knowledge's of VL there is a receipt of primary information by the special created software on the personal computer of user (fig.3).

The next stage is treatment of primary information depending on tasks which are put an user VL. This stage of creation of VL includes: work with files (maintenances, exportation and importation of information on external transmitter); processing of data (shooting, 3d-metric, mathematical calculated); research of the got results (profilogramm, topogramm etc.); retrieval-adaptation of the got data (connecting to other bases of these virtual laboratories; search of alike structures; work with a CALL-centers, interactive consultations).

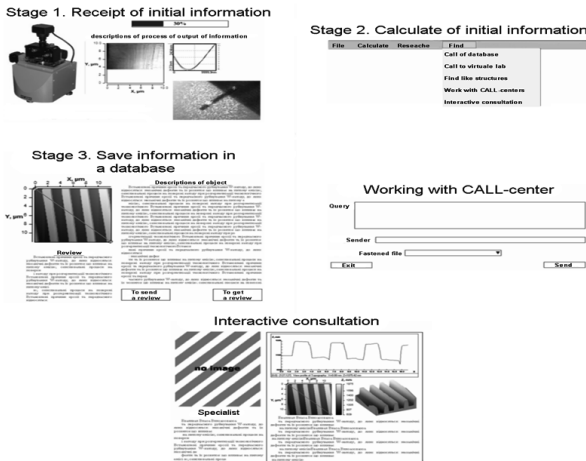


Fig. 3. Realization of virtual laboratory on the different stages (interface on the personal computer of user in the process of work of the system)

Thus, the necessity of creation of virtual laboratory of physical research of materials is grounded for a modern technological university and expedience is well-proven on the basis of results of creation of International educational and scientific Center «Micro- and nanotechnologies and equipment».

Віртуальна лабораторія фізичних досліджень матеріалів

Бондаренко М.О., Бондаренко Ю.Ю.

***Анотація.** У статті розглядається можливість створення принципово нового різновиду віртуальної лабораторії фізичних досліджень матеріалів. На прикладі створеного в Міжнародному навчально-науковому центрі «Мікро- та нанотехнології та обладнання» на кафедрі фізики Черкаського державного технологічного університету лабораторії фізичних досліджень матеріалів доведені її функціональні можливості, зв'язок з іншими лабораторіями та перспективи розвитку. Обґрунтовано можливість впровадження такої віртуальної лабораторії як в навчальний процес, так і в промисловість, а також для дослідницьких робіт. Були визначені основні переваги віртуальної лабораторії, а саме: функціональність, швидкість проведення досліджень, максимальне усунення зовнішніх дестабілізуючих факторів, таких як: кліматичні впливи, антропогенний вплив, суб'єктивні помилки вимірювань тощо.*

***Ключові слова:** віртуальна лабораторія; фізичне матеріалознавство; технологічний університет; нанометричні дослідження; атомно-силова мікроскопія*

Виртуальная лаборатория физических исследований материалов

Бондаренко М.А., Бондаренко Ю.Ю.

***Аннотация.** В статье рассматривается возможность создания принципиально новой разновидности виртуальной лаборатории физических исследований материалов. На примере созданного в Международном учебно-научном центре «Микро- и нанотехнологии и оборудование» на кафедре физики Черкасского государственного технологического университета лаборатории физических исследований материалов доказаны ее функциональные возможности, связь с другими лабораториями и перспективы развития. Обоснована возможность внедрения такой виртуальной лаборатории как в учебный процесс, так и в промышленность, а также для исследовательских работ. Были определены основные преимущества виртуальной лаборатории, а именно: функциональность, быстрота проведения исследований, максимальное устранение внешних дестабилизирующих факторов, таких как: климатические воздействия, антропогенное воздействие, субъективные ошибки измерений и т. д.*

***Ключевые слова:** виртуальная лаборатория; физическое материаловедение; технологический университет; нанометрические исследования; атомно-силовая микроскопия*

References.

1. Bondarenko M.A. Virtualnaya laboratoriya atomno-silovoy mikroskopii i nanometricheskikh issledovaniy v sovremennoy tehnologicheskom universitete (Virtual laboratory of atomic force microscopy and nanometric research in a modern technological university) / M.A.Bondarenko, M.P.Musienko, Yu.Yu.Bondarenko, L.I.Konopaltseva // Metodologicheskie aspekty skaniruyushey zondovoy mikroskopii: IX Mezhdunar.sem, 12-15 oktyabrya 2010 g: tezisy dokl. – Minsk: Belaruska navuka, 2010. – S. 136-141.
2. Bondarenko M.A. Necessity of creation of virtual laboratory of physical research of materials / M.A.Bondarenko // System analysis and information technologies SAIT 2011: Intern. conf. of science and technology, May 23-28, 2011: thesis. – Kyiv: ESC “IASA” NTUU “KPI”, 2011. – P. 404.
3. Bondarenko M.A. Sozdanie virtualnoy laboratorii atomno-silovoy mikroskopii v tehnologicheskom universitete (Creating a virtual laboratory of atomic force microscopy at the University of Technology) / M.A.Bondarenko, V.A.Andrienko, S.A.Bilokon, P.V.Petlevaniy [i dr.] // Elektronnaya mikroskopiya: XXIV Ros. konf., 29 maya – 1 iyunya 2012 g: tezisy dokl. – g.Chernogolovka, 2012. – S. 210-211.